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Phyto-diversity Assessment of Kaimur District of Bihar, Eastern India

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ABSTRACT: Inventorization and monitoring of phyto-biodiversity is essential for its sustainable use and management. In the present study, we assessed the phyto-diversity of Bihar's Kaimur district. Total species reported from the area were 190 species (155 genera and 56 families) including 48 families of dicotyledons, 5 of monocotyledons and 3 of pteridophytes. The largest two families of the area were Papilionaceae (18 species) and Poaceae (17 species). Based on habit, 99 trees 23 shrub, 15 vine and 53 herb species were reported. Various diversity indices *viz.* Shannon-Wiener Index, Concentration of dominance, Species Richness Index and Evenness were calculated for different layers. This study revealed that the Majaonda Barchiada site is the most diverse in the region, followed by Konda Bajraco, Rondi and Chakarghata Nadi. The results of the study will be very helpful for different target groups for conserving and managing and phyto-diversity of areas.

Keywords: Plant Diversity, Phytosociology, Shannon Wiener index, Evenness.

INTRODUCTION

Biological diversity implies variety and variability of all living things of all ecosystems. Understanding of forest structure and floristics are necessary for the study of forest dynamics, plant-animal interactions and nutrient cycling. A long-lasting dynamic process determines the diversity and composition of species in a region. However, the stress on forests has intensified as a result of industrialization and rapid population growth, which has led to a reduction in biodiversity. Therefore, regular assessment of forest biodiversity is essential for its sustainable use and proper management.

Floristic study of Bihar and adjoin areas has been carried out by various workers (Mukharjee 1947; Mooney 1950; Paul 1973; Biswas and Maheshshwari 1980; Bhatacharya and Sarkar 1998; Singh *et al.,* 2001). However, species inventorization alone cannot provide detailed information about ofvegetation of the area, hence, it should be supplemented by quantitative study. Different diversity indicesfor have been assessed by various researchers (Whittakar 1965; Risser and Rice 1971; Knight 1963; Peng *et al.,* 2018).

Kaimur is one the districts of Bihar. The district covers 3,332 km^2 and is located between 25°02'13" N latitude and 83°33'33" E longitude. The entire area is divided into Tropical moist deciduous forests (Group 3) and Tropical dry deciduous forests (Group 5). Each forest type is further subdivided into open, moderately dense and dense forests. The forest cover in the Kaimur district is 1,051.56 km^2, accounting for 31.56 percent of the state's total geographical area. As per density classes, 519.83 km^2 is under moderately dense forests and 531.73 km^2 in open forests. District has no dense forest, half of it is open forest, while the other half is moderately dense (FSI, 2021). Till date, no detailed account of quantitative aspect of vegetation of Kaimur district has been reported, hence, phyto-diversity of selected forest sites of Kaimur district was assessed.

MATERIALS AND METHODS

The present study was conducted in forest areas of the Kaimur district (Fig. 1). GIS Cell of Forest Research Insttute provided the random coordinate points for the collection of vegetative data. Vegetation analysis of nine random sites *viz.*, Garha Jungal, Chainpur; Chakarghata Nadi, Patpar Village; Patpur Village, Adhaura Range; Khondher, Adhaura Range; Khondher Bajrakho, Adhaura Range; Majgaonda Barchiada, Chainpur; Karkatgarh Mukka; Lohndi, Bhubhua Range and Lohndi Jamua, Bhubhua Range was carried during 2014-2015. Quadrat number and size were determined by the running mean method (Kershaw 1973) and species-area curve method (Misra 1968), respectively. Quantitative analysis of vegetation for frequency, density and dominance was calculated following Misra (1968). Ten quadrats were randomly laid on each site. Quadrat size of 10m × 10m, 3m × 3m, and 1m × 1m was kept for trees, shrubs and herbs respectively. In each quadrat, the GBH (girth at breast height at 1.37m above ground level) of each tree was measured and recoded individually. In the case of herb and shrub, the collar diameter was measured at 2.5 cm above ground level. Species were identified with the help of concerned floras and matched with DD herbarium specimens. Plant nomenclature was updated as per The Plant List (Anon., 2013). Values of Relative frequency, density and dominance were summed to get Importance Value Index (IVI). Species richness index (Dmg), Species diversity (H), concentration of dominance (CD) and evenness index were estimated following Margalef (1958); Shannon and Wiener (1963); Simpson (1949); Pielou (1966) respectively.

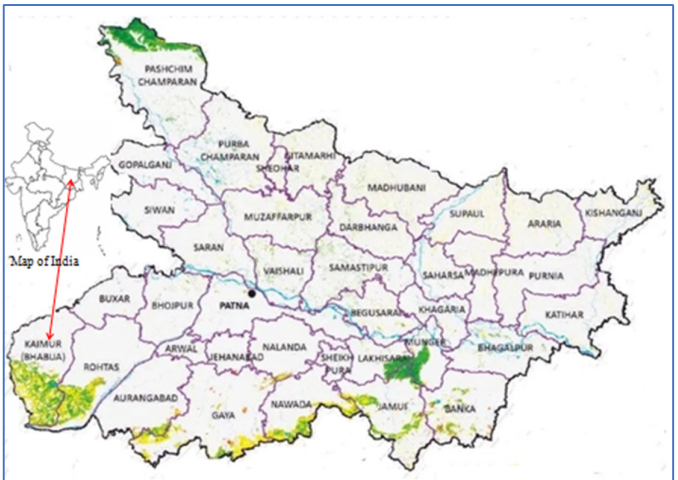

Fig.1. Location map of study area

RESULTS AND DISCUSSION

In the current study, 190 species from the forest habitats in the Kaimur district were reported (56 families, 152 genera). It consists of 48 Dicotyledons families (128 genera, 162 species), 5 Monocotyledons families (23 genera, 25 species) and 3 Pteridophyte families (3 genera, 3 species). Poaceae (17 genera, 17 species) is the largest family from the area followed by Papilionaceae (11 genera, 17 species), Rubiaceae (11 genera, 12 species), Mimosaceae (6 genera, 10 species), Asteraceae (9 genera, 9 species), Moraceae (4 genera, 9 species), Caesalpiniaceae (4 genera, 8 species), Combretaceae (3 genera, 8 species), etc. The largest genus is *Ficus* (6 species) followed by *Terminalia* (5 species), *Albizia* (3 species), *Desmodium* (3 species), etc. List of the species recorded from the study area is given Table 1- 5. Sahu *et al*. (2012) reported a total of 57 species from the dry deciduous forests of Eastern Ghats. In the Sagar district of Madhya Pradesh 36 trees, 8 shrubs, and 34 herbs were reported by Thakur (2015). Kumar *et al.* (2020) recorded a total of 14 tree species under 10 families from Amarkutir, tropical dry deciduous forest of West Bengal. Recently, Chandra *et al.* (2021 a,b; 2022a,b) reported 126 and 174 156 and 129 species from the Aurangabad, Gaya, Banka and Jamui districts of Bihar, respectively. The variation in the number of species in the present work may be because of climatic and edaphic conditions and the extent of the area covered under the study.

The status of a species is an important indicator of its conservation and sustainable utilization. The Importance Value Index (IVI) is a measure of how dominant a species is in a given forest area. IVI was estimated for the tree, shrubby and herbaceous layers. A high importance value indicates that the species is well represented in the area. In the tree layer, *Terminalia arjuna* was the most dominant species with the highest IVI values in site-II (243.14). *Shorea robusta* had the highest IVI at site-I (83.29) and site-VII (47.34). The highest IVI estimated for sites-III, IV, V, VI, VIII and IX were 51.81 (*Lannea coromandelica*), 46.08 (*Ficus racemosa*), 28.70 (*Diospyros melanozylon*), 28.96 (*Anogeissus latifolia*), 45.99 (*Anogeissus pendula*) and 65.82 (*Lagerstroemia parviflora*) respectively. In the shrubby layer, the highest IVI estimated for site-I, II and IV were *Flemingia chappar* (90.58), *Mitragyna parviflora* (110.19) and *Lantana camara* var. *aculeata* (88.01) respectively. *Holorrhena pubescens* was the most dominant species with the highest IVI values in 6 sites i.e. site-III (50.93), site -V (95.05), site -VI (91.78), site-VII (64.67), site-VIII (75.72), site-IX (148.14). The herbaceous layer was dominated by *Chrysopogon fulvus* in 3 sites i.e., site-V (108.27), site-VI (110.93) and site-VIII (101.05). *Slaginella bryopteris* was the dominant species in 2 sites i.e., site-III (64.02) and site-VIII (70.17). *Sida Cordata*, *Cyperus rotundus*, *Heteropogon contortus* and *Chloris dolichostachya* had the highest IVI values at the site -I (50.45), site-II(66.02), site-IV (71.72) and site-IX (46.46) respectively.

Different diversity indices such as Shannon-Wiener Diversity Index (H), Concentration of Dominance (cd), Evenness (E) and Species Richness Index (Dmg) for different growth forms at different sites in the Kaimur district were estimated for comparison (Table 6). A higher value of species richness index (Dmg) indicates higher diversity of species. The study revealed that in the tree layer, the total number of species were highest at Majgaonda Barchiada site (35 spp.) followed by Khondher Bajrakho (33 spp.), Lohndi (27 spp.) etc. and lowest was found at Chakarghata Nadi (03 spp.). In case of shrubby layer, highest value was found at Patpur Village and Majgaonda Barchiada (23 spp. each) followed by Khondher (19 spp.), Khondher Bajrakho (17 spp.) etc. and lowest was found at Chakarghata Nadi (03 spp.). The herbaceous layer had the highest number of Species at Khondher (32 spp.) followed by Lohndi (29 spp.), Khondher Bajrakho (24 spp.), and the lowest value was found in Chakarghata Nadi (15 spp.). Species Richness Index (Dmg) also showed similar trend.

In the tree layer, the highest Diversity Index (H) was estimated for the Majgaonda Barchiada site (3.24) and the lowest at Chakarghata Nadi (0.49). In the shrubby layer, the highest value was also estimated for Majgaonda Barchiada (2.57) and the lowest at Chakarghata Nadi (0.10). In the herbaceous layer, the

highest value was estimated for Garha Jungal (2.87) and the lowest for Karkatgarh Mukka (1.40). The high value of the Diversity Index (H) reflects the variability in the type of species and heterogeneity in communities, whereas the low value suggests the homogeneity in the community. In the study, the diversity index value ranges from 0.10 to 3.24 as reported in tropical forests of the Indian subcontinent by Sundarapandian and Swamy (2000); Himanshi and Jakhar (2020); Chandra *et al.* (2021a, b & 2020a,b).

In the tree layer, the Concentration of Dominance (cd) was highest in the case of Chakarghata Nadi site (0.76) and lowest in case of Majgaonda Barchiada (0.02). The shrubby layer had the highest value at Lohndi Jamua (0.40) and the lowest at Majgaonda Barchiada and Patpur Village site (0.12). In the herbaceous layer, the highest value was estimated for Karkatgarh Mukka (0.34) and the lowest at Garha Jungal (0.08). The high value of CD indicates the homogenous nature of the community, such communities are dominated by few dominant species, while the lower value of CD shows the dominance shared by many plant species (Kumar and Saikia 2018).

In case of tree layer, the highest Evenness (E) value was estimated for the Khondher site (0.94) and the lowest at Chakarghata Nadi (0.44). In case of shrubby layer, highest value was observed for Chakarghata Nadi (1.00) and lowest at Lohndi Jamua (0.575). In the herbaceous layer, the highest value was estimated for Garha Jungal (0.86) and lowest for Karkatgarh Mukka (0.51). A high value of Evenness (E) suggests that species are evenly distributed and vice-versa. In the current study, Pielou's Evenness Index (E) for the tree, shrubby and herbaceous layers revealed a pattern that was also seen in other tropical Indian forests such as Udaipur, Rajasthan (Kumar *et al.,* 2010), Western Ghats (Sundarapandian and Swamy 2000), Bundelkhand region of Uttar Pradesh (Verma *et al.,* 2015) South West Haryana (Himanshi and Jakhar 2020), Aurangabad, and Gaya, Banka and Jamui districts of Bihar (Chandra *et al.* 2021a, b & 2022 a, b).

Table 1: Tree species reported from the study area.

Sr. No.	Species	Family
1.	*Acacia catechu* (L.f.) Willd.	Mimosaceae
2.	*Acacia nilotica* (L.) Delile	Mimosaceae
3.	*Adina cordifolia* (Roxb.) Hook.f. ex Brandis	Rubiaceae
4.	*Aegle marmelos* (L.) Corr.	Rutaceae
5.	*Ailanthus excelsa* Roxb.	Simarubiaceae
6.	*Albizia chinensis* (Osbeck) Merr	Mimosaceae
7.	*Albizia lebbeck* (L.) Benth	Mimosaceae
8.	*Albizia odoratissima* (L. f.) Benth.	Mimosaceae
9.	*Alstonia scholaris* (L.) R.Br.	Apocynaceae
10.	*Anogeissus latifolia* (Roxb. ex DC.) Wall. ex Guill. & Perr	Combretaceae
11.	*Anogeissus pendula* Edgew.	Combretaceae
12.	*Anthocephalus chinensis* (Lamk.) A.Rich. ex Walp	Rubiaceae
13.	*Artocarpus heterophyllus* Lam.	Moraceae
14.	*Azadirachta indica* A. Juss.	Meliaceae
15.	*Bauhinia purpurea* L.	Caesalpiniaceae
16.	*Bauhinia racemosa* Lam.	Caesalpiniaceae
17.	*Bauhinia variegata* L.	Caesalpiniaceae
18.	*Bombax ceiba* L.	Bombacaceae
19.	*Borassus flabellifer* L.	Arecaceae
20.	*Boswellia serrata* Roxb. ex Colebr	Burseraceae
21.	*Bridelia montana* (Roxb.)Willd.	Euphorbiaceae
22.	*Bridelia retusa* (L.) Spreng.	Euphorbiaceae
23.	*Buchanania lanzan* Spreng	Anacardiaceae
24.	*Butea monosperma* (Lam.) Taub	Papilionaceae
25.	*Callistemon viminalis* (Sol. ex Gaertn.) G.Don ex Loud	Myrtaceae
26.	*Calotropis gigantea* R.Br.	Asclepiadaceae
27.	*Careya arborea* Roxb.	Barringtoniaceae
28.	*Casearia graveolens* Dalz	Flacortiaceae
29.	*Casearia tomentosa* Roxb.	Flacortiaceae
30.	*Cassia fistula* L.	Caesalpiniaceae
31.	*Cassia siamea* Lam.	Caesalpiniaceae
32.	*Cassine glauca* (Rottb.) Kuntze	Celastraceae
33.	*Catunaregam spinosa* (Thunb.) Tirveng	Rubiaceae
34.	*Ceiba pentandra* (L.) Gaertn	Bombacaceae
35.	*Ceriscoidesturgida* (Roxb.) Tirveng	Rubiaceae
36.	*Cochlospermum religiosum* (L.) Alston	Cochlospermaceae
37.	*Cordia macleodii* (Griff.) Hook. f. & Thoms.	Boraginaceae

38.	*Dalbergia lanceolaria* L. f.	Papilionaceae
39.	*Dalbergia sissoo* Roxb.	Papilionaceae
40.	*Delonix regia* (Boj. ex Hook.) Raf.	Caesalpiniaceae
41.	*Dichrostachys cinerea* (L.) Wight & Arn.	Mimosaceae
42.	*Diospyros melanoxylon* Roxb.	Ebenaceae
43.	*Diospyros montana* Roxb.	Ebenaceae
44.	*Ehretia laevis* Roxb.	Boraginaceae
45.	*Erythrina suberosa* Roxb.	Papilionaceae
46.	*Erythrina variegata* L.	Papilionaceae
47.	*Ficus arnottiana* (Miq.) Miq.	Moraceae
48.	*Ficus benghalensis* L.	Moraceae
49.	*Ficus mollis* Vahl	Moraceae
50.	*Ficus racemosa* L.	Moraceae
51.	*Ficus religiosa* L.	Moraceae
52.	*Ficus virens* Ait.	Moraceae
53.	*Flacourtia indica* (Burm.f.) Merr.	Flacortiaceae
54.	*Gardenia latifolia* Ait.	Rubiaceae
55.	*Garuga pinnata* Roxb.	Burseraceae
56.	*Gmelina arborea* Roxb.	Verbenaceae
57.	*Helicteresisora* L.	Sterculiaceae
58.	*Holarrhena pubescens* (Buch. -Ham.) R.Br.	Apocynaceae
59.	*Holoptelea integrifolia* (Roxb.) Planch.	Ulmaceae
60.	*Hymenodictyon orixense* (Roxb.) Mabb.	Rubiaceae
61.	*Lagerstroemia parviflora* Roxb.	Lythraceae
62.	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae
63.	*Madhuca longifolia* (Koenig) Macbr.	Sapotaceae
64.	*Mangifera indica* L.	Anacardiaceae
65.	*Melia azedarach* L.	Meliaceae
66.	*Miliusa tomentosa* (Roxb.) Finet &Gagenpain	Annonaceae
67.	*Miliusa velutina* (Dunal) Hook. f. & Thoms.	Annonaceae
68.	*Mitragyna parvifolia* (Roxb.) Korth	Rubiaceae
69.	*Moringa oleifera* Lam.	Moringaceae
70.	*Morus australis* Poir.	Moraceae
71.	*Nyctanthes arbor-tristis* L.	Oleaceae
72.	*Ougeiniaoojeinensis* (Roxb.) Hochr	Papilionaceae
73.	*Phoenix loureiroi* var. *pedunculata* (Griff.) Govaerts	Arecaceae
74.	*Phoenix sylvestris* (L.) Roxb.	Arecaceae
75.	*Phyllanthus emblica* L.	Phyllanthaceae
76.	*Pithecellobium dulce* (Roxb.) Benth	Mimosaceae
77.	*Polyalthia longifolia* (Sonn.) Thw	Annonaceae
78.	*Pongamia pinnata* (L.)Pierre	Papilionaceae
79.	*Psidium guajava* L.	Myrtaceae
80.	*Pterocarpus marsupium* Roxb.	Papilionaceae
81.	*Schleichera oleosa* (Lour.) Oken	Sapindaceae
82.	*Semecarpus anacardium* L.f.	Anacardiaceae
83.	*Shorea robusta* Gaertn.f.	Dipterocarpaceae
84.	*Soymida febrifuga* (Roxb.) A. Juss.	Meliaceae
85.	*Spondias pinnata* (L.f.) Kurz	Anacardiaceae
86.	*Sterculia urens* Roxb.	Sterculiaceae
87.	*Sterospermum chelonoides* (L.f.) DC.	Bignoniaceae
88.	*Streblus asper* Lour.	Moraceae
89.	*Syzygiumcumini* (L.) Skeels	Myrtaceae
90.	*Tamarindus indica* L.	Caesalpiniaceae
91.	*Terminalia alata* Heyne ex Roth	Combretaceae
92.	*Terminalia arjuna* (Roxb. ex DC.) Wight & Arn	Combretaceae
93.	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae
94.	*Terminalia catappa* L.	Combretaceae
95.	*Terminalia chebula* Retz.	Combretaceae
96.	*Wendlandia heynei* (Roem. & Schult.) Sant. & Merch	Rubiaceae
97.	*Wrightia tinctoria* (Roxb.) R.Br.	Apocynaceae
98.	*Ziziphus mauritiana* Lam.	Rhamnaceae
99.	*Ziziphus xylopyra* (Retz.) Willd.	Rhamnaceae

Table 2: Shrub species reported from the study area.

Sr. No.	Species	Family
1.	*Asparagus adscendens* Buch. -Ham. ex Roxb.	Liliaceae
2.	*Carissa opaca* Stapf ex Haines	Apocynaceae
3.	*Clerodendrum viscosum* Vent.	Verbenaceae
4.	*Crotalaria retusa* L.	Papilionaceae (Papilionaceae)
5.	*Desmodium gangeticum* (L.) DC.	Papilionaceae (Papilionaceae)
6.	*Desmodium pulchellum* (L.) Benth.	Papilionaceae (Papilionaceae)
7.	*Euphorbia nivulia* Buch. -Ham.	Euphorbiaceae
8.	*Flemingia chappar* Buch. Ham. ex Benth.	Papilionaceae (Papilionaceae)
9.	*Flemingia macrophylla* (Willd.) Prain ex Merr.	Papilionaceae (Papilionaceae)
10.	*Grewia hirsuta* Vahl.	Teliaceae
11.	*Hibiscus rosa-sinensis* L.	Malvaceae
12.	*Ipomoea carnea* Jacq.	Convolvulaceae
13.	*Ixora pavetta* Andr.	Rubiaceae
14.	*Lantana camara* L. var. *aculeata* (L.) Mold.	Verbenaceae
15.	*Mimosa himalayana* Gamble.	Mimosaceae
16.	*Nerium oleander* L.	Apocynaceae
17.	*Pavetta crassicaulis* Bremek.	Rubiaceae
18.	*Phyllanthus reticulates* Poir.	Phyllanthaceae
19.	*Thevetia peruviana* (Pers.) Merr.	Apocynaceae
20.	*Urariapicta* (Jacq.) Desv. ex DC.	Papilionaceae (Papilionaceae)
21.	*Urena lobata* L.	Malvaceae
22.	*Vitex negundo* L.	Verbenaceae
23.	*Woodfordia fruticosa* (L.) Kurz	Lythraceae

Table 3: Climber species reported from eleven forest sites of Kaimur district.

Sr. No.	Species	Family
1.	*Acacia pennata* (L.) Willd.	Mimosaceae
2.	*Asparagus racemosus* Willd.	Liliaceae
3.	*Atylosia scarabaeoides* (L.) Benth.in Miq.	Papilionaceae (Papilionaceae)
4.	*Butea parviflora* Roxb.	Papilionaceae (Papilionaceae)
5.	*Celastrus paniculatus* Willd.	Celastraceae
6.	*Cissampelos pareira* L. var. *hirsuta* (Buch. -Ham.ex DC.) Forman	Menispermaceae
7.	*Cissus repanda* Vahl	Vitaceae (Ampelidaceae)
8.	*Cocculus hirsutus* (L.) Diels	Menispermaceae
9.	*Combretum roxburghii* Spreng.	Combretaceae
10.	*Hemidesmus indicus* (L.) R.Br.	Asclepediaceae
11.	*Ichnocarpus frutescens* (L.) R.Br.	Apocynaceae
12.	*Olax scandens* Roxb.	Oleaceae
13.	*Smilax zeylanica* L.	Smilacaceae
14.	*Ventilago denticulata* Willd	Rhamnaceae
15.	*Ziziphus oenoplia* (L.) Mill.	Rhamnaceae

Table 4: Herb species reported the study area.

Sr. No.	Species	Family
1.	*Achyranthes aspera* L.	Amaranthaceae
2.	*Ageratum conyzoides* L.	Asteraceae (Compositae)
3.	*Blepharis maderaspatensis* (L.) Roth	Acanthaceae
4.	*Blumea mollis* (D.Don) Merr.	Asteraceae (Compositae)
5.	*Byttneria herbacea* Roxb.	Sterculiaceae
6.	*Canscora diffusa* (Vahl) R.Br.	Gentianaceae
7.	*Cassia tora* L.	Caesalpiniaceae
8.	*Celosia argentea* L.	Amaranthaceae
9.	*Corchorus olitorius* L.	Tiliaceae
10.	*Cyathocline purpurea* (Buch. -Ham. ex D.Don) Kuntze	Asteraceae (Compositae)
11.	*Desmodium triflorum* (L.) DC.	Papilionaceae (Papilionaceae)
12.	*Dicoma tomentosa* Cass.	Asteraceae (Compositae)
13.	*Elephantopus scaber* L.	Asteraceae (Compositae)
14.	*Euphorbia hirta* L.	Euphorbiaceae
15.	*Evolvulus alsinoides* (L.) L.	Convolvulaceae
16.	*Evolvulus nummularius* (L.) L.	Convolvulaceae
17.	*Gnaphalium pensylvanicum* Willd.	Asteraceae (Compositae)
18.	*Hygrophila schulli* (Buch. -Ham.) M.R. & S.M. Almeida	Acanthaceae
19.	*Hyptis suaveolens* (L.) Poit.	Lamiaceae
20.	*Launaea procumbens* (Roxb.) Ramayya & Rajagopal	Asteraceae (Compositae)
21.	*Polygonum hydropiper* L.	Polygonaceae
22.	*Rungia pectinata* (L.) Nees	Acanthaceae
23.	*Scoparia dulcis* L.	Scrophulariaceae
24.	*Sida acuta* Burm.f.	Malvaceae
25.	*Sida cordata* (Burm.f.) Borassum	Malvaceae
26.	*Spermacocea rticularis* L.f.	Rubiaceae
27.	*Tephrosia purpurea* (L.) Pers.	Papilionaceae (Papilionaceae)
28.	*Tridex procumbens* L.	Asteraceae (Compositae)
29.	*Triumfetta rhomboidea* Jacq.	Tiliaceae
30.	*Urena sinuata*L.subsp. *sinuata* (L.) Borassum	Malvaceae
31.	*Vernonia cinerea* (L.) Less.	Asteraceae (Compositae)

Table 5: Grasses, Sedges and Pteridophytes reported from the study area.

Sr. No.	Species	Family
Grasses		
1.	*Apludamutica* L.	Poaceae
2.	*Aristida adscensionis* L.	Poaceae
3.	*Arundinella pumila* (Hochst. ex A.Rich.)Steud	Poaceae
4.	*Bothriochloa pertusa* (L.)A. Camus	Poaceae
5.	*Brachiaria ramosa* (L.)Stapf	Poaceae
6.	*Chloris dolichostachya* Lagasca,	Poaceae
7.	*Chrysopogon fulvus* (Spr.)Chiov	Poaceae
8.	*Cynodon dactylon* (L.)Pers.	Poaceae
9.	*Dendrocalamus strictus* (Roxb.)Nees	Poaceae
10.	Digitaria ciliaris (Retz.)Koel	Poaceae
11.	*Eragrostis tenella* (L.)P. Beauv. ex Roem. & Schult.	Poaceae
12.	*Eragrostiella nardoides* (Trin.)Bor	Poaceae
13.	*Heteropogon contortus* (L.)P. Beauv. ex Roem. & Schult	Poaceae
14.	*Imperata cylindrica* (L.) Raeusch.	Poaceae
15.	*Oplismenus burmannii* (Retz.)P. Beauv	Poaceae
16.	*Pennisetum glaucum* (L.) R. Br.	Poaceae
17.	*Themeda triandra* Forssk.	Poaceae
Sedges		
1	*Cyperus rotundus* L.	Cyperaceae
2	*Mariscus paniceus* (Rottb.) Vahl	Cyperaceae
Pteridophytes		
1	*Adiantum incisum*Forssk.	Adiantaceae
2	*Selaginella bryopteris* (L.)Baker	Selaginellaceae
3	*Lygodium flexuosum* (L.)Sw	Lygodiaceae

Table 6: Diversity indices of different growth forms of selected sites of Kaimur District of Bihar.

Sr. No.	Sites	Tree Layer					Shrubby Layer					Herbaceous Layer				
		Total Species	Dmg	H	CD	E	Total Species	Dmg	H	CD	E	Total Species	Dmg	H	CD	E
1.	Garha Jungal, Chainpur	21	3.01	2.40	0.17	0.79	18	1.85	2.10	0.20	0.73	28	2.22	2.87	0.080	0.86
2.	Chakarghata Nadi, Patpar Village	3	0.35	0.49	0.76	0.44	3	0.28	0.10	0.33	1.00	15	1.06	1.99	0.19	0.74
3.	Patpur Village, Adhaura Range	18	2.61	2.62	0.09	0.91	23	2.36	2.49	0.12	0.79	22	1.61	2.04	0.19	0.66
4.	Khondher, Adhaura Range	21	3.14	2.85	0.07	0.94	19	1.97	2.05	0.27	0.70	32	2.37	2.40	0.15	0.69
5.	Khondher Bajrakho, Adhaura Range	33	4.67	3.17	0.06	0.91	17	1.79	2.23	0.17	0.78	24	1.76	2.33	0.13	0.73
6.	Majgaonda Barchiada, Chainpur	35	5.04	3.24	0.02	0.91	23	2.38	2.57	0.12	0.82	19	1.43	2.19	0.16	0.75
7.	Karkatgarh Mukka	26	3.80	2.84	0.08	0.87	14	1.51	2.30	0.13	0.87	16	1.17	1.40	0.34	0.51
8.	Lohndi, Bhubhua Range	27	3.93	2.87	0.09	0.87	15	1.56	2.11	0.18	0.78	29	2.14	2.28	0.20	0.68
9.	Lohndi Jamua, Bhubhua Range	23	3.25	2.62	0.12	0.84	12	1.21	1.43	0.40	0.58	22	1.58	2.11	0.17	0.68

(Dmg=Species Richness Index; H=Diversity Index; CD = Concentration of Dominance; E=Evenness

CONCLUSIONS

In the present work a total of 190 species (56 families, 155 genera) were reported from the forest sites of Kaimur district. It includes 48 Dicotyledons families (129 genera, 165 species), 5 monocotyledons families (23 genera, 25 species) and 3 Pteridophyte families (3 genera, 3 species). Largest family reported from the area is Poaceae (17 genera, 17 species) followed by Papilionaceae (12 genera, 18 species), Rubiaceae (11 genera, 12 species), Mimosaceae (6 genera, 10 species), Asteraceae (9 genera, 9 species), Moraceae (4 genera, 9 species), Caesalpiniaceae (4 genera, 8 species), Combretaceae (3 genera, 8 species) etc. Largest genus is *Ficus* (6 species) followed by *Terminalia* (5 species), *Albizia* (3 species), *Desmodium* (3 species) etc. On the basis of habit, there are 99 tree, 23 shrub, 15 climber and 53 herb species in the area. Important native tree species of the district are *Shorea robusta, Madhuca longifolia* var. *latifolia, Buchanania lanzan, Terminalia bellirica, Terminalia alata, Butea monosperma, Lagerstroemia parviflora, Mytragyna parvifolia, Adina cordifolia, Albizia lebbeck, Anogeissus latifolia, Dalbergia lanceolaria* etc. The presence of *Lantana camara* var. *aculeata* was observed in the district. It is

expected that species may pose threat to natural vegetation in the future. Therefore, suitable management strategies should be adopted to check the invasion of invasive species. The study will be extremely useful for the preparation of future working plan of the forest division and plant diversity related assessment studies.

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